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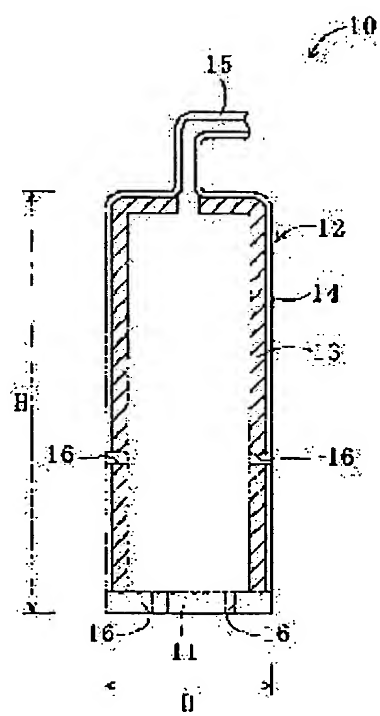
(54) APPARATUS FOR MANUFACTURING FULLERENE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an apparatus for manufacturing fullerene with a stable quality, in large quantities, economically and easily.

SOLUTION: The manufacturing apparatus 10 for manufacturing the fullerene is provided with a reaction furnace 12 equipped with a combustion burner part 11 having a carbon containing compounds feeding part and an oxygen containing compound feeding port and, in which the fullerene is manufactured by burning raw materials of the carbon containing compounds with the oxygen containing gas. Because at least the inside of the lower part of the furnace 12 is provided with refractories, the temperature of the furnace can be rised sufficiently, the fullerene of a stable quality can be produced, and damage of the furnace can be hindered. Thereby, the cost for repairs can be reduced, and the manufacturing can be performed economically.



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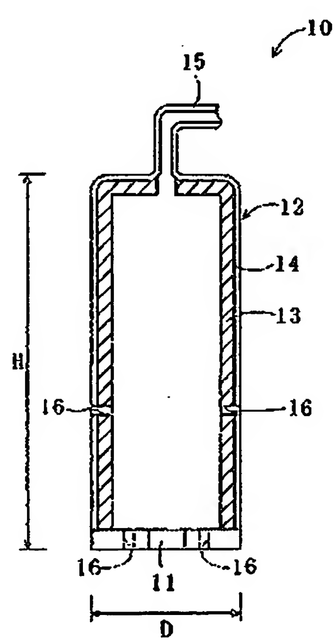
(54)【発明の名称】　フラーレンの製造装置

(57)【要約】
【課題】　安定した品質のフラーレンを大量に且つ安価に、そして容易に製造可能なフラーレンの製造装置を提供する。
【解決手段】　炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部１１を備える反応炉１２で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置１０であって、反応炉１２の少なくとも下部内側が耐火材１３であるので、反応炉１２内の温度を十分高めることができ、安定した品質のフラーレンを生成できると共に、反応炉１２の損傷を抑制できることとで補修費用を低減でき経済的である。



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【特許請求の範囲】

【請求項１】　炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、前記反応炉の少なくとも下部内側が耐火材であることを特徴とするフラーレンの製造装置。

【請求項２】　請求項１記載のフラーレンの製造装置において、前記反応炉の下部内側には耐火材が備えられると共に、前記反応炉の上部外側には水冷部が設けられたことを特徴とするフラーレンの製造装置。

【請求項３】　請求項２記載のフラーレンの製造装置において、前記水冷部には水冷管及び／又はジャケットを使用することを特徴とするフラーレンの製造装置。

【請求項４】　請求項２又は３記載のフラーレンの製造装置において、前記水冷部の冷媒には水又は有機溶剤を使用することを特徴とするフラーレンの製造装置。

【請求項５】　請求項１～４のいずれか１項に記載のフラーレンの製造装置において、前記反応炉の炉本体を耐熱鋼又は耐熱合金で構成することを特徴とするフラーレンの製造装置。

【請求項６】　請求項１～５のいずれか１項に記載のフラーレンの製造装置において、前記耐火材をアルミナ系耐火材又はマグネシア系耐火材としたことを特徴とするフラーレンの製造装置。

【請求項７】　請求項１～６のいずれか１項に記載のフラーレンの製造装置において、前記反応炉内の圧力を１０～５００ｔｏｒｒとすることを特徴とするフラーレンの製造装置。

【請求項８】　請求項１～７のいずれか１項に記載のフラーレンの製造装置において、前記反応炉内でのガス流を層流とすることを特徴とするフラーレンの製造装置。

【請求項９】　請求項１～８のいずれか１項に記載のフラーレンの製造装置において、前記酸素含有ガス中には、０又は０を超え９０モル％以下の不活性ガスが含まれていることを特徴とするフラーレンの製造装置。

【請求項１０】　請求項１～９のいずれか１項に記載のフラーレンの製造装置において、前記反応炉内の温度を６００～２３００℃の範囲とすることを特徴とするフラーレンの製造装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、フラーレン（例えば、C_{60}、C_{70}等）を製造可能なフラーレンの製造装置に関する。

【０００２】

【従来の技術】フラーレン（以下、フラーレン類とも言う）は、ダイヤモンド、黒鉛に次ぐ第三の炭素同素体の総称であり、C_{60}、C_{70}などに代表されるように、５員環と６員環のネットワークで閉じた中空殻状の炭素分子

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である。このフラーレンの存在が最終的に確認されたのは比較的最近の１９９０年のことであり、比較的新しい炭素材料であるが、その特殊な分子構造ゆえに特異的な物理的性質を示すことが認められ、例えば以下のような広範囲の分野に渡り、革新的な用途開発が急速に展開されつつある。

（１）超硬材料への応用

フラーレンを前駆体とすることで、微細結晶粒子をもつ人工ダイヤモンドの製造が可能となるため、付加価値のある耐摩耗材料への利用が期待されている。

（２）医薬品への応用

C_{60}誘導体及び光デバイスを用いることで、例えば、抗癌剤、エイズ、骨粗鬆症、アルツハイマー治療薬、造影剤、ステント材料等の用途としての研究が進められている。

（３）超伝導材料への応用

フラーレン薄膜に金属カリウムをドープすることで、１８Ｋという高い転移温度を持つ超伝導材料を製造できることが発見され、多方面から注目を集めている。

（４）半導体製造への応用

レジストにC_{60}を混ぜることで、レジスト構造がより一層強化されることを利用し、次世代半導体の製造への応用が期待されている。このようにフラーレンは、次世代を担う新材料、新素材として多方面から注目されている。なお、各種炭素数を有するフラーレンの中でも、C_{60}及びC_{70}は比較的合成が容易であり、それゆえ今後の需要も爆発的に高まることが予想されている。

【０００３】また、現在知られているフラーレンの製造方法としては、以下に示す方法が挙げられる。

（１）レーザー蒸着法：希ガス中に置かれた炭素ターゲットに高エネルギー密度のパルスレーザーを照射し、炭素原子の蒸発により合成する方法。まず、希ガスが流れる石英管を電気炉の中に置き、グラファイト試料をその石英管の中に置く。そして、ガスの流れの上流側からグラファイト試料にレーザーを照射し蒸発させることで、電気炉出口付近の冷えた石英管の内壁にC_{60}やC_{70}などのフラーレンを含む煤（すす）を付着させる。なお、このレーザー蒸着法は、グラファイト試料のレーザーショット当たりの蒸発量が僅かであるため、大量製造には不向きである。

（２）抵抗加熱法：ヘリウムガスで満たされた真空の容器の中でグラファイト棒を通電加熱し昇華させる方法。なお、この抵抗加熱法は、回路における電気抵抗ロスが大きいため、大量製造に不向きである。

（３）アーク放電法：数十ｋＰａ中のヘリウムガス中で２本のグラファイト電極を軽く接触させたり、あるいは１～２ｍｍ程度離した状態でアーク放電を起こし、陽極の炭素を昇華させる方法。このアーク放電法は、現在工場規模での大量製造に用いられている。

（４）高周波誘導加熱法：抵抗加熱やアーク放電を使う

代わりに、高周波誘導によりグラファイト原料に過電流を流し、グラファイト原料を加熱し蒸発させる方法。
（5）燃焼法：ヘリウム等の不活性ガスと酸素との混合ガス中でベンゼン等の炭化水素原料を不完全燃焼させる方法。この燃焼法を用いた場合、ベンゼン燃料の数%が煤となり、その10%程度がフラーレンとなるため、製造効率は良くない。しかし、複製する煤（フラーレン等）を液体燃料等に使用可能な点、また製造装置が単純である点で、アーク放電法に対抗する大量生産法として注目されている。
（6）ナフタレン熱分解法：ナフタレンを約1000℃で熱分解させる方法。
【0004】上記したように、現在までさまざまなフラーレンの合成法が提案されているが、いずれの方法によってもこれまでにフラーレンを安価に、しかも大量に製造する方法は確立されていなかった。しかし、上記した方法の中において、燃焼法は、フラーレンの大量生産に向き、またフラーレンの合成域における最高温度が1700℃程度と他の方法と比べて比較的低温であり、他の方法に比べて容易に製造することができる。例えば、特表平6－507879号公報には、炭素含有化合物を火炎中で燃焼させ凝縮物を収集するフラーレンの製造方法が提案されている。
【0005】
【発明が解決しようとする課題】しかしながら、上記した燃焼法によるフラーレンの製造方法には以下の問題がある。フラーレンはすす状物質中に含まれて生成するが、燃焼法ではすす状物質中に含まれるフラーレンの割合が低いため経済的でない。そこで、このフラーレンの生成割合をいかに高めるかが大きな課題となっている。また、燃焼法を用いて安定した品質のフラーレンを生成させるためには、原料となる炭素含有化合物を均一に気化させ反応させる必要がある。そのためには、原料となる炭素含有化合物（炭化水素原料）を高温に加熱する必要があるので、反応炉が熱によって損傷を受ける可能性がある。これにより、例えば、反応炉の補修作業が増えるので、フラーレンの生産性を低下させたり、また補修作業に多くのコストが必要となり経済的でない。本発明はかかる事情に鑑みてなされたもので、安定した品質のフラーレンを大量に且つ安価に、そして容易に製造可能なフラーレンの製造装置を提供することを目的とする。
【0006】
【課題を解決するための手段】前記目的に沿う本発明に係るフラーレンの製造装置は、炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、反応炉の少なくとも下部内側が耐火材である。このように構成することで、最も高温となる反応炉下部の放熱を、耐火材によって抑制できる。ここで、本発明に係るフラーレンの製造装置において、反応炉の下部内側には耐火材が備えられると共に、反応炉の上部外側には水冷部を設けることが好ましい。このように構成することで、最も高温となる反応炉下部の放熱を耐火材によって抑制できると共に、反応炉上部を水冷部により冷却できる。本発明に係るフラーレンの製造装置において、水冷部には水冷管及び／又はジャケットを使用することが好ましい。このように構成することで、水冷部の構成を簡単にできる。
【0007】本発明に係るフラーレンの製造装置において、水冷部の冷媒には水又は有機溶剤を使用することが好ましい。これにより、水冷部の冷却を容易に行うことができる。本発明に係るフラーレンの製造装置において、反応炉の炉本体を耐熱鋼又は耐熱合金で構成することが好ましい。このように、反応炉の炉本体を高温に耐え得る鋼又は合金で構成するので、反応炉内の温度を十分に高めた場合においても、炉本体の熱による損傷を低減できる。本発明に係るフラーレンの製造装置において、耐火材をアルミナ系耐火材又はマグネシア系耐火材とすることが好ましい。これにより、反応炉内の温度を十分に高めた場合においても、熱による耐火材の損傷を抑制できると共に、耐火材によって放熱を抑制できる。
【0008】本発明に係るフラーレンの製造装置において、反応炉内の圧力を10～500torrとすることが好ましい。本発明に係るフラーレンの製造装置において、反応炉内でのガス流を層流とすることが好ましい。本発明に係るフラーレンの製造装置において、酸素含有ガス中には、0又は0を超え90モル%以下の不活性ガスが含まれていることが好ましい。本発明に係るフラーレンの製造装置において、反応炉内の温度を600～2300℃の範囲とすることが好ましい。
【0009】
【発明の実施の形態】続いて、添付した図面を参照しつつ、本発明を具体化した実施の形態につき説明し、本発明の理解に供する。ここに、図1は本発明の第1の実施の形態に係るフラーレンの製造装置の説明図、図2は本発明の第2の実施の形態に係るフラーレンの製造装置の説明図である。
【0010】図1に示すように、本発明の第1の実施の形態に係るフラーレンの製造装置10は、炭素含有化合物供給口（図示しない）と酸素含有ガス供給口（図示しない）とを有する燃焼用バーナー部11を備える反応炉12で、原料となる炭素含有化合物と酸素含有ガスとを使用し、炭素含有化合物を燃焼（不完全燃焼）させてフラーレンを製造する装置であり、反応炉12の少なくとも下部内側（本実施の形態では内側全て）が耐火材13である。以下、詳しく説明する。
【0011】反応炉12の炉本体14は、耐熱鋼で構成され、略円柱状の形状となっており、その大きさは、外径Dが例えば0．8～5m程度、高さHが例えば外径D

の2～4倍程度である。この炉本体14の上端には、反応炉12内で生成したフラーレンを下流側の分離部（図示しない）へ送るための配管15が一体的に接続されている。なお、炉本体14においては、炉本体14を同一の材料としても、また高温域と低温域とで異なる材料を用いてもよい。具体的には、用いる温度域において使用可能な耐熱鋼であればよく、炉本体14を構成する耐熱鋼としては、例えば、Mo鋼、Cr－Mo鋼、Mo－V鋼、Cr－Mo－V鋼、Cr－Ni－Mo鋼、Cr－Mo－W－V鋼等の低合金耐熱鋼（500℃以下の温度で使用可能）や、マルテンサイト系耐熱鋼（600～650℃の範囲の温度以下で使用可能）、フェライト系耐熱鋼、SUS304、SUS304L、SUS316、SUS316L、SUS310S等のオーステナイト系耐熱鋼（700℃付近の温度まで使用可能）、耐熱鋳鋼等のように耐食用より少し炭素量が高いステンレス系耐熱鋼等を使用できる。また、炉本体を耐熱合金で構成してもよく、耐熱合金としては、例えば、Cr－Ni－Fe系とCr－Ni－Co－Fe系とに大別されるFe基超耐熱合金（約760℃付近の温度まで使用可能）、Ni基超耐熱合金（900～1000℃の高温度で使用可能）、Co基超耐熱合金（800～850℃の温度範囲で使用可能）等を使用できる。

【0012】一方、反応炉12の底部に設けられた燃焼用バーナー部11には、燃料となる炭素含有化合物と酸素含有ガスをそれぞれ供給する炭素含有化合物供給口と酸素含有ガス供給口がそれぞれ複数設けられ、フラーレンを生成させるための燃焼流が形成される。このため、反応炉12の下部の炉内温度が最も高くなり易い。なお、この複数の炭素含有化合物供給口及び酸素含有ガス供給口の形状は任意であり、平面視して実質的に円形、楕円形、矩形、多角形等や、ひょうたん型の不定形であってもよい。また、炭素含有化合物供給口及び酸素含有ガス供給口の配置位置は任意であるが、反応炉12の上方へ燃焼流を均一に流すため、反応炉12の軸心を中心とした同一又は同心円周上に等間隔で、複数の供給口を配置することが好ましい。また、反応炉12には、真空手段の一例である真空ポンプ（図示しない）が接続され、反応炉12内の圧力を大気圧未満としている。

【0013】そして、反応炉12の下側側部には、フラーレンの原料となる炭素含有化合物を供給するための供給口16が設けられている。なお、この供給口16の個数は任意であるが、反応炉12内でフラーレンを均一に生成させるためには、この供給口16を反応炉12の側部に均等な間隔で多数設けることが好ましい。また、供給口16の位置は、反応炉12内で生成させるフラーレン前駆体及びフラーレンの滞留時間を長くするため、反応炉12の下側、更には下端部に設けることが好ましい。従って、供給口16は、反応炉12の底部（図1中の二点鎖線位置）に多数設けることも可能であり、この場合、反応炉12の軸心を中心として、同一又は同心円周上に配置することが好ましい。この際、供給口16の開口端部は、反応炉12の底面と略同一平面上にあっても、また突出していてもよく、反応炉12の軸心に向かって傾斜させることも可能である。

【0014】反応炉12の炉本体14の内側には、従来公知のアルミナ系耐火材又はマグネシア系耐火材で構成される耐火材13が配置されている。このとき、反応炉12内の温度が1800℃程度までであれば、アルミナ系耐火材を使用することが好ましく、2300℃程度まで上昇する場合は、マグネシア系耐火材を使用することが好ましい。また、反応炉12の高さ方向の温度分布に応じて、反応炉12の内側に配置する耐火材の種類を、アルミナ系耐火材又はマグネシア系耐火材に適宜変えることも可能である。これにより、フラーレンの製造条件に応じた経済的なフラーレンの製造装置を提供できる。なお、耐火材13の厚みは任意であるが、反応炉12内の温度を考慮し、炉本体14の損傷を抑制できる厚み、例えば3～10cm程度に設定することが好ましい。

【0015】続いて、上記したフラーレンの製造装置10を用い、フラーレンを製造する方法について説明する。まず、燃焼用バーナー部11から燃料となる炭素含有化合物と酸素含有ガスとを供給し、これらを燃焼させることで高温の燃焼ガス流を反応炉12の上方（下流側）に向かって発生させる。そして、供給口16から反応炉12内に原料となる炭素含有化合物を供給し、反応炉12中を大気圧未満として、炭素含有化合物を燃焼（不完全燃焼）させフラーレンを生成させる。以下、詳しく説明する。

【0016】この燃料となる炭素含有化合物と酸素含有ガスは、反応炉12内に入る前に混合して燃焼させる予混合燃焼であっても、また独立したノズルからそれぞれ反応炉12内に供給し燃焼させる拡散燃焼であってもよい。また、予混合燃焼と拡散燃焼とを組合せてもよい。このように、反応炉12の下部では、フラーレンを生成させるための高温の燃焼流を発生させることが目的であり、その燃焼方法は上記した予混合燃焼や拡散燃焼、また層流燃焼、乱流燃焼、高温空気燃焼等の従来公知のいかなる燃焼方法であってもよい。また、燃焼は、完全燃焼であっても、不完全燃焼であってもよい。

【0017】燃料及び原料となる炭素含有化合物としては任意のものを使用でき、例えば、水素、一酸化炭素、天然ガス、石油ガス等の燃料ガス、重油等の石油系液体燃料、クレオソート油等の石油系液体燃料、メタン、エタン、プロパン、エチレン、プロピレン等の直鎖又は分岐鎖を有する脂肪族飽和もしくは不飽和炭化水素、ベンゼン、トルエン、o－キシレン、m－キシレン、p－キシレン、ナフタレン、アントラセン等の芳香族（系）炭化水素等やこれらの混合物等が挙げられる。中でも精製した芳香族炭化水素が好ましく、特にベンゼンやトルエ

ン等の芳香族炭化水素を用いることが好ましい。なお、原料の純度は高い方が好ましく、中でも芳香族炭化水素を用いる場合には、その純度が１００％に近いほど良い。

【００１８】また、酸素含有ガスとしては、純酸素（酸素含有ガス中の不活性ガス量が０％のもの）や、０を超え９０モル％以下の不活性ガス（例えば、ヘリウムガス、アルゴンガス）を含むガスを使用することが好ましい。ここで、酸素含有ガス中の不活性ガスの量が多いほど、反応炉内の雰囲気を酸素が希薄な状態にし、均一な品質を備えたフラーレンを製造できるが、不活性ガスの量が９０モル％を超えた場合、フラーレンの製造に必要な熱エネルギーを造り出すための酸素量が確保できない。なお、不活性ガスは、供給用の専用ノズルから供給しても良いし、また炭素含有化合物及び／又は酸素含有ガス中に予め混合させておくことも可能である。

【００１９】ここで、反応炉１２内の圧力は、生成するフラーレンの生成効率を高めるため、大気圧未満、即ち１０～５００ｔｏｒｒ、好ましくは５０～４００ｔｏｒｒ、更には１００～４００ｔｏｒｒとすることが好ましい。また、反応炉１２内のフラーレン前駆体及びフラーレンの滞留時間を長くするため、反応炉１２内のガス流を層流（例えば、１０～１００ｃｍ／ｓｅｃ程度）とすることが好ましい。そして、炭素含有化合物を均一に気化させ反応（熱分解）させるためには、フラーレンの生成領域、即ち反応炉１２内の温度を十分高温雰囲気とすることが好ましく、反応炉１２内の温度（平均温度）を６００～２３００℃、好ましくは１０００～２０００℃、更には１２００～１８００℃の範囲とすることが好ましい。この条件の下、原料となる炭素含有化合物を燃焼（不完全燃焼）させ、フラーレンを生成させる。

【００２０】反応炉１２で生成した粗フラーレン（例えば、C_{60}やC_{70}、及びこれ以上の分子量を有する高次フラーレン等を含んだフラーレン）とその他の煤成分とは、分離部にて燃焼ガスから分離される。そして、従来公知の溶媒抽出法や昇華法等により、フラーレンと他の煤成分とを分離すればよい。なお、燃焼法にて生成させる際、温度調整することで、フラーレンを気体状態とし、その他の煤成分を固体状態として、分離部にてフラーレンをその他の煤成分と分離してもよい。このためには、分離部に入る粗フラーレンの温度を３００℃以上とすることが必要である。なお、３００℃未満では、生成したフラーレンが一部固体状態となって分離部を通過できないため、回収量が減少する可能性がある。一方、温度が高すぎると、分離部の劣化を促進したり、またフラーレン以外の煤成分の一部が分離部を通過し、回収したフラーレン中に混入してしまう可能性がある。このため、粗フラーレンの温度を、３００～２３００℃、更には３００～１５００℃とすることが好ましい。

【００２１】次に、本発明の第２の実施の形態に係るフラーレンの製造装置２０について説明するが、耐火材２１を反応炉２２の下部内側に備えたこと、及び反応炉２２の上部に水冷部２３を設けたこと以外、本発明の第１の実施の形態に係るフラーレンの製造装置１０と同じであるため、同一の構成要素には同一の番号を付し詳しい説明を省略する。図２に示すように、本発明の第２の実施の形態に係るフラーレンの製造装置２０は、炭素含有化合物供給口（図示しない）と酸素含有ガス供給口（図示しない）とを有する燃焼用バーナー部１１を備える反応炉２２で、原料となる炭素含有化合物と酸素含有ガスとを使用し、炭素含有化合物を燃焼（不完全燃焼）させてフラーレンを製造する装置であり、反応炉２２の下部内側には耐火材２１が備えられると共に、反応炉２２の上部外側には水冷部２３が設けられている。

【００２２】耐火材２１は、反応炉２２の炉内温度が最も高くなる反応炉２２の下部、例えば反応炉２２の高さの１／４～１／２程度の位置に配置されている。この耐火材２１の上端は、耐火材２１の厚みの分だけ炉本体１４の内面から突出しているが、耐火材の上端部を炉本体１４の内面に向かって傾斜させることも可能である。これにより、反応炉２２内のガス流を、より層流に近づけることができるので、均一な品質を備えたフラーレンを製造できる。また、水冷部２３は水冷管２４で構成されており、冷媒には水を使用し、水冷管２４の内部に連続的に水（例えば、１０～３０℃程度）が供給されている。この水冷管２４は、水冷部２３の下端から上端にかけて、炉本体１４の上部外側に螺旋状（連続的）に配置することも、また反応炉２２の高さ方向に、それぞれ個別に独立して配置することも可能である。ここで、水冷管２４を、個別に独立して配置した場合は、反応炉２２の高さ方向の温度分布に応じて、各水冷管２４に異なる温度の水（例えば、５～５０℃程度）をそれぞれ流すことも可能である。これにより、炉本体１４の温度を、炉本体１４が熱による損傷を受けない程度の温度に調節できるので、反応炉２２の長期使用が可能となり経済的である。

【００２３】そして、水冷部には、二重構造となったジャケットを使用することもでき、このジャケットと水冷管２４とを組合せて使用することも可能である。なお、冷媒には水を使用することなく、有機溶剤であるオイルや前記した炭素含有化合物を使用することも可能である。ここで、炭素含有化合物を使用した場合、反応炉２２内から発生する熱が冷媒となる炭素含有化合物に供給されるので、炭素含有化合物の温度を上昇（気化）させることができる。従って、このように予熱した炭素含有化合物を燃料として使用することで、燃焼流の燃焼温度を高めることができ、経済的である。

【００２４】以上、本発明を、実施の形態を参照して説明してきたが、本発明は何ら上記した実施の形態に記載の構成に限定されるものではなく、特許請求の範囲に記

載されている事項の範囲内で考えられるその他の実施の形態や変形例も含むものである。例えば、前記第１の実施の形態においては、反応炉の内側全てが耐火材である場合について説明した。しかし、反応炉の高さ方向の温度分布により、例えば、反応炉の下部内側のみを耐火材とすることも、また反応炉の上部内側を除く内側全部を耐火材とすることも可能である。これにより、フラーレンの製造温度に応じて耐火材の配置場所を選択できるので、耐火材を多く使用した場合と比較して経済的である。

【００２５】また、前記実施の形態においては、反応炉内側に耐火材を配置した場合について説明したが、反応炉内側に耐火材を被覆することも可能である。これにより、耐火材を配置する場合と比較して、炉本体の内面から突出する耐火材の厚みを薄くできるので、反応炉内のガス流を、より層流に近づけることができる。そして、前記実施の形態においては、炭素含有化合物を燃焼、例えば不完全燃焼させフラーレンを生成させた場合について説明したが、完全燃焼させた場合でも、フラーレンが生成する場合もある。

【００２６】

【発明の効果】請求項１～１０記載のフラーレンの製造装置においては、最も高温となる反応炉下部の放熱を、耐火材によって抑制できる。従って、原料となる炭素含有炭化物を均一に気化させ反応させるため、反応炉内の温度を十分に高めることができるので、安定した品質のフラーレンを生成できるフラーレンの製造装置を提供できる。また、反応炉の損傷を抑制できるので、反応炉の補修作業の頻度を低減でき、フラーレンの生産性を向上させ、また反応炉の補修費用を低減でき経済的である。特に、請求項２記載のフラーレンの製造装置においては、最も高温となる反応炉下部の放熱を耐火材によって抑制できると共に、反応炉上部を水冷部により冷却できる。従って、反応炉の高さ方向の温度分布に応じて、放熱の抑制及び反応炉の冷却を行うことができるので、補修作業を低減でき、フラーレンの生産性を向上させると共に作業性が良好となるフラーレンの製造装置を提供できる。請求項３記載のフラーレンの製造装置においては、水冷部の構成を簡単にできるので経済的である。

【００２７】請求項４記載のフラーレンの製造装置においては、水冷部の冷却を容易に行うことができるので作業性が良好である。請求項５記載のフラーレンの製造装置においては、反応炉の炉本体を高温に耐え得る鋼又は合金で構成するので、反応炉内の温度を十分に高めた場合においても、炉本体の熱による損傷を低減できる。従って、長期間使用可能な反応炉を提供できるので、経済性が良好となる。請求項６記載のフラーレンの製造装置においては、反応炉内の温度を十分に高めた場合においても、熱による耐火材の損傷を抑制できると共に、耐火材によって放熱を抑制できる。従って、反応炉の熱に対する耐久性を更に高められるので、フラーレンの生産性を向上させ、しかも反応炉の補修費用を低減でき経済的である。

【００２８】請求項７記載のフラーレンの製造装置においては、反応炉内の圧力を１０～５００ｔｏｒｒにするので、フラーレンの生成効率を高めることができる。請求項８記載のフラーレンの製造装置においては、反応炉内でのガス流を層流とするので、フラーレンの生成領域におけるフラーレン前駆体及びフラーレンの滞留時間を更に長くでき、フラーレンの生成効率を高めることができる。請求項９記載のフラーレンの製造装置においては、フラーレンの生成が希薄な酸素状態の下で行われるので、フラーレンの生成領域の温度分布を均一にし、安定した品質のフラーレンを製造できる。請求項１０記載のフラーレンの製造装置においては、反応炉内の温度を６００～２３００℃の高温にするので、炭素含有化合物を均一に気化させ反応させて、安定した品質のフラーレンを製造できる。

【図面の簡単な説明】

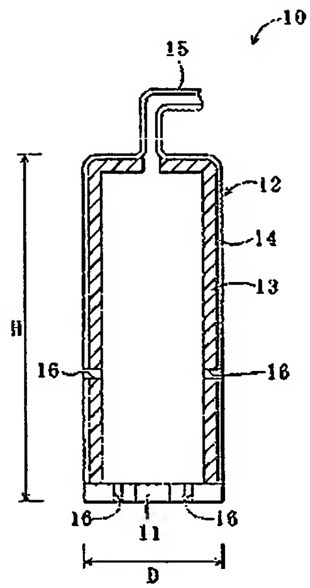
【図１】本発明の第１の実施の形態に係るフラーレンの製造装置の説明図である。

【図２】本発明の第２の実施の形態に係るフラーレンの製造装置の説明図である。

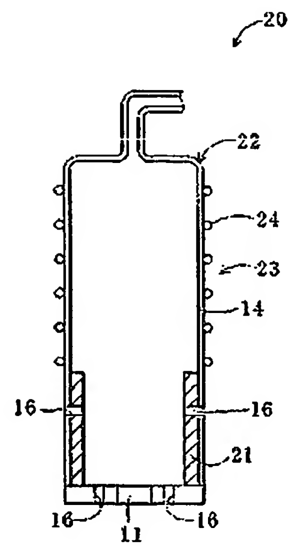
【符号の説明】

１０：フラーレンの製造装置、１１：燃焼用バーナー部、１２：反応炉、１３：耐火材、１４：炉本体、１５：配管、１６：供給口、２０：フラーレンの製造装置、２１：耐火材、２２：反応炉、２３：水冷部、２４：水冷管

【図１】



【図２】



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3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The manufacturing installation of the fullerene which is the manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene with a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, and is characterized by the lower inside being [of said fission reactor] refractory material at least.
[Claim 2] The manufacturing installation of the fullerene characterized by preparing the water-cooled section in the up outside of said fission reactor in the manufacturing installation of fullerene according to claim 1 while having refractory material inside [lower] said fission reactor.
[Claim 3] The manufacturing installation of the fullerene characterized by using the water-cooled tube and/or a jacket for said water-cooled section in the manufacturing installation of fullerene according to claim 2.
[Claim 4] The manufacturing installation of the fullerene characterized by using water or an organic solvent for the refrigerant of said water-cooled section in the manufacturing installation of fullerene according to claim 2 or 3.
[Claim 5] The manufacturing installation of the fullerene characterized by constituting the furnace body of said fission reactor from heat-resisting steel or a heat-resistant alloy in the manufacturing installation of fullerene given in any 1 term of claims 1-4.
[Claim 6] The manufacturing installation of the fullerene characterized by using said refractory material as alumina system refractory material or magnesia system refractory material in the manufacturing installation of fullerene given in any 1 term of claims 1-5.
[Claim 7] The manufacturing installation of the fullerene characterized by setting the pressure in said fission reactor to 10 - 500torr in the manufacturing installation of fullerene given in any 1 term of claims 1-6.
[Claim 8] The manufacturing installation of the fullerene characterized by making the gas stream in said fission reactor into a laminar flow in the manufacturing installation of fullerene given in any 1 term of claims 1-7.
[Claim 9] The manufacturing installation of the fullerene characterized by exceeding 0 or 0 and containing the inert gas not more than 90 mol % in said oxygen content gas in the manufacturing installation of fullerene given in any 1 term of claims 1-8.
[Claim 10] The manufacturing installation of the fullerene characterized by making temperature in said fission reactor into the range of 600-2300 degrees C in the manufacturing installation of fullerene given in any 1 term of claims 1-9.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacturing installation of the fullerene which can manufacture fullerene (for example, C60, C70 grade).
[0002]
[Description of the Prior Art] Fullerene (henceforth fullerene) is the generic name of the third carbon allotrope which ranks second to a diamond and a graphite, and as represented in C60, C70, etc., it is the carbon molecule of the shape of hollow husks closed in the network of five membered-rings and six membered-rings. Although it is comparatively that existence of this fullerene was finally checked and it is a comparatively new carbon material, it is admitted that that special molecular structure, therefore specific physical property are shown, for example, innovative application development is being quickly developed over the wide range following fields.
(1) Since manufacture of an artificial diamond with a fine crystal grain child is attained by using application fullerene to a superhard ingredient as a precursor, use to an abrasion resistance material with added value is expected.
(2) By using application C60 derivative and the optical device to drugs, research as an application of an anticancer agent, an acquired immunode-ficiency syndrome, osteoporosis, the Alzheimer remedy, a contrast medium, a stent ingredient, etc. is advanced.
(3) It is discovered that the superconducting material which has a high transition temperature called 18K with doping metallic potassium in the application fullerene thin film to a superconducting material can be manufactured, and since various, attract attention.
(4) By mixing C60 with the application resist to semi-conductor manufacture, it uses that resist structure is strengthened further and the application to manufacture of a next-generation semi-conductor is expected. Thus, since fullerene is various as the exotic material which bears the next generation, and new materials, it attracts attention. In addition, C60 and C70 are comparatively easy to compound also in the fullerene which has various carbon numbers, and it is expected that future need so also increases explosively.
[0003] Moreover, the approach shown below is mentioned as the manufacture approach of fullerene learned now.
(1) Laser vacuum deposition : how to irradiate the pulse laser of a high energy consistency at the carbon target placed into rare gas, and compound by evaporation of a carbon atom. First, the quartz tube with which rare gas flows is placed into an electric furnace, and a graphite sample is placed into the quartz tube. And the soot (soot) containing fullerene, such as C60 and C70, is made to adhere to the wall of the quartz tube with which near the electric furnace outlet got cold by irradiating laser and evaporating it in a graphite sample, from the upstream of the flow of gas. In addition, since this laser vacuum deposition has the slight evaporation per laser shot of a graphite sample, it is unsuitable for extensive manufacture.
(2) Resistance heating method : the approach to which carry out energization heating and a graphite rod is made to sublimate in the container of the vacuum filled with gaseous helium. In addition, since this

resistance heating method has the large electric resistance loss in a circuit, it is unsuitable for extensive manufacture.
(3) Arc discharge method : the approach to which the carbon of a lifting and an anode plate is made to sublimate arc discharge in the condition of having contacted two graphite electrodes lightly in the gaseous helium in dozens kPa(s), or having detached about 1-2mm. This arc discharge method is used for extensive manufacture on a current works scale.
(4) Radio frequency heating method : how to heat a sink and a graphite raw material in a graphite raw material by RF induction, and to evaporate an eddy current instead of using resistance heating and arc discharge.
(5) Combustion method : the approach of carrying out the incomplete combustion of the hydrocarbon raw materials, such as benzene, in the mixed gas of inert gas, such as helium, and oxygen. Since several% of a benzene fuel serves as soot and those about 10% becomes fullerene when this combustion method is used, manufacture effectiveness is not good. However, the soot (fullerene etc.) to reproduce is observed as the mass-producing method for opposing an arc discharge method at the point usable to liquid fuel etc., and the point that a manufacturing installation is simple.
(6) Naphthalene thermal decomposition method : the approach of carrying out the pyrolysis of the naphthalene at about 1000 degrees C.
[0004] Although the synthesis method of various fullerene to current was proposed as described above, the method of manufacturing fullerene cheaply and in large quantities by any approach until now was not established. However, toward mass production method of fullerene, the maximum temperature in the synthetic region of fullerene is low temperature comparatively compared with about 1700 degrees C and other approaches, and can manufacture [be / it / under / of the above-mentioned approach / setting] a combustion method easily compared with other approaches. For example, the manufacture approach of the fullerene which a carbon content compound is burned in a flame in the Patent Publication Heisei No. 507879 [six to] official report, and collects condensates in it is proposed.
[0005]
[Problem(s) to be Solved by the Invention] However, there are the following problems in the manufacture approach of the fullerene by the above-mentioned combustion method. Although it is contained in the soot-like matter and generated, since the rate of fullerene of the fullerene contained in the soot-like matter in a combustion method is low, it is not economical. Then, it has been a big technical problem how the generation rate of this fullerene is raised. Moreover, in order to make the fullerene of the quality stabilized using the combustion method generate, it is necessary to make homogeneity evaporate the carbon content compound used as a raw material, and to make it react. For that purpose, since it is necessary to heat the carbon content compound (hydrocarbon raw material) used as a raw material to an elevated temperature, a fission reactor may receive damage with heat. Since the repair activity of a fission reactor increases by this, it is not reduce the productivity of fullerene and needed [much] for a repair activity, and economical. This invention was made in view of this situation, and aims at offering the manufacturing installation of the fullerene which can be manufactured cheaply and easily in large quantities [fullerene / of the stable quality].
[0006]
[Means for Solving the Problem] the manufacturing installation which the carbon content compound and oxygen content gas which the manufacturing installation of the fullerene concerning this invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, and serve as a raw material are burned, and manufactures fullerene -- it is -- a fission reactor -- the lower inside is refractory material at least. Thus, with constituting, heat dissipation of the fission reactor lower part which serves as an elevated temperature most can be controlled with refractory material. Here, while having refractory material inside [lower] a fission reactor in the manufacturing installation of the fullerene concerning this invention, it is desirable to prepare the water-cooled section in the up outside of a fission reactor. Thus, while being able to control with constituting heat dissipation of the fission reactor lower part which serves as an elevated temperature most with refractory material, the fission

reactor upper part can be cooled by the water-cooled section. In the manufacturing installation of the fullerene concerning this invention, it is desirable to use the water-cooled tube and/or a jacket for the water-cooled section. Thus, the configuration of the water-cooled section can be simplified with constituting.

[0007] In the manufacturing installation of the fullerene concerning this invention, it is desirable to use water or an organic solvent for the refrigerant of the water-cooled section. Thereby, the water-cooled section can be cooled easily. In the manufacturing installation of the fullerene concerning this invention, it is desirable to constitute the furnace body of a fission reactor from heat-resisting steel or a heat-resistant alloy. Thus, since the furnace body of a fission reactor is constituted from the steel or the alloy which can bear an elevated temperature, when the temperature in a fission reactor is fully raised, damage by the heat of a furnace body can be reduced. In the manufacturing installation of the fullerene concerning this invention, it is desirable to use refractory material as alumina system refractory material or magnesia system refractory material. When the temperature in a fission reactor is fully raised, while being able to control damage on the refractory material by heat by this, heat dissipation can be controlled with refractory material.

[0008] In the manufacturing installation of the fullerene concerning this invention, it is desirable to set the pressure in a fission reactor to 10 - 500torr. In the manufacturing installation of the fullerene concerning this invention, it is desirable to make the gas stream in a fission reactor into a laminar flow. In the manufacturing installation of the fullerene concerning this invention, it is desirable that exceed 0 or 0 and the inert gas not more than 90 mol % is contained in oxygen content gas. In the manufacturing installation of the fullerene concerning this invention, it is desirable to make temperature in a fission reactor into the range of 600-2300 degrees C.

[0009]

[Embodiment of the Invention] Then, referring to the attached drawing, it explains per gestalt of the operation which materialized this invention, and an understanding of this invention is presented. The explanatory view of the manufacturing installation of the fullerene which drawing 1 requires for the gestalt of operation of the 1st of this invention here, and drawing 2 are the explanatory views of the manufacturing installation of the fullerene concerning the gestalt of operation of the 2nd of this invention.

[0010] As shown in drawing 1 , the manufacturing installation 10 of the fullerene concerning the gestalt of operation of the 1st of this invention With the fission reactor 12 equipped with the burner section 11 for combustion which has a carbon content compound feed hopper (not shown) and oxygen content gas supply opening (not shown) the equipment which the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene -- it is -- a fission reactor 12 -- the lower inside (the gestalt of this operation all insides) is refractory material 13 at least. Hereafter, it explains in detail.

[0011] The furnace body 14 of a fission reactor 12 consists of heat-resisting steel, and serves as an approximate circle column-like configuration, and an outer diameter D is [about 0.8-5m and height H of the magnitude] about 2 to 4 times of for example, the outer diameter D. The piping 15 for sending the fullerene generated in the fission reactor 12 to the separation section (not shown) of the downstream is connected to the upper limit of this furnace body 14 in one. In addition, in the furnace body 14, an ingredient which is different also considering the furnace body 14 as the same ingredient in a pyrosphere and a low-temperature region may be used. In the temperature region to be used, specifically as heat-resisting steel which constitutes the furnace body 14 that what is necessary is just usable heat-resisting steel For example, Mo steel, Cr-Mo steel, Mo-V steel, Cr-Mo-V steel, Cr-nickel-Mo steel, Low alloy heat-resisting steel (usable at the temperature of 500 degrees C or less), such as Cr-Mo-W-V steel, Martensitic heat resisting steel (usable at below the temperature of the range of 600-650 degrees C), Stainless steel system heat-resisting steel with a high carbon content etc. can be used for a while from the object for anticorrosion like the austenitic heat resisting steel (usable to the temperature near 700 degree C) of ferritic heat resisting steel, SUS304, SUS304L, SUS316, SUS316L, and SUS310S grade, and heat resistant cast steel. Moreover, a furnace body may be constituted from a heat-resistant alloy,

and the iron base superalloy (usable to the temperature near about 760 degree C) divided roughly into a Cr-nickel-Fe system and a Cr-nickel-Co-Fe system, an Ni base superalloy (usable at 900-1000-degree C high temperature), Co radical superalloy (usable in a 800-850-degree C temperature requirement), etc. can be used as a heat-resistant alloy, for example.

[0012] On the other hand, two or more carbon content compounds used as a fuel, carbon content compound feed hoppers which supply oxygen content gas, respectively, and oxygen content gas supply openings are prepared in the burner section 11 for combustion prepared in the pars basilaris ossis occipitalis of a fission reactor 12, respectively, and the combustion style for making fullerene generate is formed in it. For this reason, whenever [furnace temperature / of the lower part of a fission reactor 12] tends to become the highest. In addition, it may be arbitrary, and plane view of the configuration of two or more of these carbon content compound feed hoppers and oxygen content gas supply opening may be carried out, and they may be circular, an ellipse form, a rectangle, a polygon, etc. and the indeterminate form of a gourd mold substantially. Moreover, although the arrangement location of a carbon content compound feed hopper and oxygen content gas supply opening is arbitrary, in order to pass a combustion style to homogeneity above the fission reactor 12, the thing which were centered on the axial center of a fission reactor 12 and for which it is regular intervals and two or more feed hoppers are arranged on the same or a concentric circle periphery is desirable. Moreover, the vacuum pump (not shown) which is an example of a vacuum means is connected to a fission reactor 12, and the pressure in a fission reactor 12 is made under into atmospheric pressure in it.

[0013] And the feed hopper 16 for supplying the carbon content compound used as the raw material of fullerene is formed in the bottom flank of a fission reactor 12. In addition, although the number of this feed hopper 16 is arbitrary, in order to make homogeneity generate fullerene in a fission reactor 12, it is desirable to form a majority of these feed hoppers 16 in the flank of a fission reactor 12 at equal spacing. Moreover, in order that the location of a feed hopper 16 may lengthen the residence time of the fullerene precursor made to generate in a fission reactor 12, and fullerene, it is desirable the fission reactor 12 bottom and to prepare in the lower limit section further. Therefore, the feed hopper 16 is possible also for preparing a large number in the pars basilaris ossis occipitalis (two-dot chain line location in drawing 1) of a fission reactor 12, and it is desirable in this case the same or to arrange on a concentric circle periphery focusing on the axial center of a fission reactor 12. Under the present circumstances, even if the open end of a feed hopper 16 is on the base of a fission reactor 12, and an abbreviation same flat surface, it is possible to have projected and to also make it incline toward the axial center of a fission reactor 12.

[0014] Inside the furnace body 14 of a fission reactor 12, the refractory material 13 which consists of a well-known alumina system refractory material or magnesia system refractory material is arranged conventionally. If the temperature in a fission reactor 12 is to about 1800 degrees C at this time, it is desirable to use alumina system refractory material, and when going up to about 2300 degrees C, it is desirable to use magnesia system refractory material. Moreover, it is also possible to change suitably into alumina system refractory material or magnesia system refractory material the class of refractory material arranged inside a fission reactor 12 according to the temperature distribution of the height direction of a fission reactor 12. Thereby, the manufacturing installation of the economical fullerene according to the manufacture conditions of fullerene can be offered. In addition, although the thickness of refractory material 13 is arbitrary, it is desirable to set in consideration of the temperature in a fission reactor 12 to the about thickness which can control damage on the furnace body 14, for example, 3-10cm.

[0015] Then, how to manufacture fullerene is explained using the manufacturing installation 10 of the above-mentioned fullerene. First, the carbon content compound and oxygen content gas which serve as a fuel from the burner section 11 for combustion are supplied, and a combustion gas style hot by burning these is generated toward the upper part (downstream) of a fission reactor 12. And the carbon content compound used as a raw material is supplied in a fission reactor 12 from a feed hopper 16, a carbon content compound is burned by making the inside of a fission reactor 12 under into atmospheric pressure (incomplete combustion), and fullerene is made to generate. Hereafter, it explains in detail.

[0016] Even if the carbon content compound and oxygen content gas used as this fuel are premixed combustion mixed and burned before entering in a fission reactor 12, they may be diffusive burning which supplies in a fission reactor 12, respectively and is burned from the independent nozzle. Moreover, premixed combustion and diffusive burning may be combined. Thus, it may be the purpose to generate the hot combustion style for making fullerene generate in the lower part of a fission reactor 12, and the combustion method may be what kind of conventionally well-known combustion methods, such as the above-mentioned premixed combustion, diffusive burning and laminar-flow combustion, turbulent flow combustion, and elevated-temperature air combustion. Moreover, combustion may be perfect combustion or may be incomplete combustion.
[0017] Aromatic series (system) hydrocarbons, etc. such mixture, etc., such as the aliphatic series saturation which can use the thing of arbitration as a carbon content compound used as a fuel and a raw material, for example, has a straight chain or branched chain, such as petroleum system liquid fuel, such as petroleum system liquid fuel, such as fuel gas, such as hydrogen, a carbon monoxide, natural gas, and petroleum gas, and a fuel oil, and creosote oil, methane, ethane, a propane, ethylene, and a propylene, or unsaturated hydrocarbon, benzene, toluene, O-xylene, meta xylene, para xylene, naphthalene, and an anthracene, be mentioned The aromatic hydrocarbon refined especially is desirable and it is desirable to use aromatic hydrocarbon, such as benzene and toluene, especially. In addition, its higher one is desirable, and when using aromatic hydrocarbon especially, it is so good that the purity of the purity of a raw material is close to 100%.
[0018] Moreover, it is desirable to use pure oxygen (that whose amount of inert gas in oxygen content gas is 0%), and the gas which exceeds 0 and contains the inert gas not more than 90 mol % (for example, gaseous helium, argon gas) as oxygen content gas. Here, the fullerene which oxygen changed the ambient atmosphere in a fission reactor into the thin condition, and was equipped with uniform quality can be manufactured so that there are many amounts of the inert gas in oxygen content gas, but when the amount of inert gas exceeds 90-mol %, the amount of oxygen for making heat energy required for manufacture of fullerene cannot be secured. In addition, as for inert gas, it is possible to supply from the exclusive nozzle for supply, and to also make it mix beforehand in a carbon content compound and/or oxygen content gas.
[0019] Here, in order that the pressure in a fission reactor 12 may raise the generation effectiveness of the fullerene to generate, it is desirable to be preferably referred to as 50 - 400torr, and further 100 - 400torr ten to 500 torr under atmospheric pressure. Moreover, in order to lengthen the fullerene precursor in a fission reactor 12, and the residence time of fullerene, it is desirable to make the gas stream in a fission reactor 12 into a laminar flow (for example, 10 - 100 cm/sec extent). And in order to make a carbon content compound react by making homogeneity evaporate (pyrolysis), it is desirable to make enough temperature in the generation field 12 of fullerene, i.e., a fission reactor, into an elevated-temperature ambient atmosphere, and it is desirable to make preferably 600-2300 degrees C (mean temperature) of temperature in a fission reactor 12 into the range of 1000-2000 degrees C and further 1200-1800 degrees C. The carbon content compound used as a raw material is burned under this condition (incomplete combustion), and fullerene is made to generate.
[0020] The rough fullerene (for example, fullerene containing the high order fullerene which has C60, C70, and the molecular weight beyond this) and the other soot components which were generated with the fission reactor 12 are separated from combustion gas in the separation section. And what is necessary is just to separate fullerene and other soot components by a well-known solvent extraction method, the well-known sublimating method, etc. conventionally. In addition, in case it is made to generate with a combustion method, by carrying out a temperature control, fullerene may be made into a gaseous state and fullerene may be separated with other soot components in the separation section by making other soot components into a solid state. For that, it is required to make temperature of the rough fullerene included in the separation section into 300 degrees C or more. In addition, at less than 300 degrees C, since a part of generated fullerene will be in a solid state and cannot pass the separation section, the amount of recovery may decrease. On the other hand, if temperature is too high, degradation of the separation section may be promoted, and a part of soot components other than fullerene may pass,

and it may mix the separation section into the collected fullerene. For this reason, it is desirable to make temperature of rough fullerene into 300-2300 degrees C and further 300-1500 degrees C.

[0021] Next, although the manufacturing installation 20 of the fullerene concerning the gestalt of operation of the 2nd of this invention is explained, since it is the same as the manufacturing installation 10 of the fullerene concerning the gestalt of operation of the 1st of this invention except having had refractory material 21 inside [lower] the fission reactor 22, and having formed the water-cooled section 23 in the upper part of a fission reactor 22, the same number is given to the same component and detailed explanation is omitted. As shown in drawing 2 , the manufacturing installation 20 of the fullerene concerning the gestalt of operation of the 2nd of this invention With the fission reactor 22 equipped with the burner section 11 for combustion which has a carbon content compound feed hopper (not shown) and oxygen content gas supply opening (not shown) It is equipment which the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene, and while having refractory material 21 inside [lower] a fission reactor 22, the water-cooled section 23 is formed in the up outside of a fission reactor 22.

[0022] Refractory material 21 is arranged in 1 / about four to 1/2 location of the lower part of the fission reactor 22 with which whenever [furnace temperature / of a fission reactor 22] becomes the highest, for example, the height of a fission reactor 22. Although the upper limit of this refractory material 21 has projected only the part of the thickness of refractory material 21 from the inside of the furnace body 14, it is possible to also make the upper limit section of refractory material incline toward the inside of the furnace body 14. Thereby, since the gas stream in a fission reactor 22 can be brought more close to a laminar flow, the fullerene equipped with uniform quality can be manufactured. Moreover, the water-cooled section 23 consists of the water-cooled tubes 24, water is used for a refrigerant, and water (for example, about 10-30 degrees C) is continuously supplied to the interior of the water-cooled tube 24. this water-cooled tube 24 -- the upper limit from the lower limit of the water-cooled section 23 -- applying -- the up outside of the furnace body 14 -- being spiral (continuous) -- it is also possible to also arrange and to arrange independently according to an individual in the height direction of a fission reactor 22, respectively. Here, when the water-cooled tube 24 has been arranged independently according to an individual, it is also possible to pour the water (for example, about 5-50 degrees C) of temperature which is different in each water-cooled tube 24 according to the temperature distribution of the height direction of a fission reactor 22, respectively. Since it can adjust by this to the temperature of extent from which the furnace body 14 does not receive damage according the temperature of the furnace body 14 to heat, it attains [long-term use of a fission reactor 22] and is economical.

[0023] And the jacket used as dual structure can also be used for the water-cooled section, and it is also possible to use it combining this jacket and water-cooled tube 24. In addition, it is also possible to use the oil which is an organic solvent, and the above mentioned carbon content compound, without using water for a refrigerant. Here, since the carbon content compound with which the heat generated out of a fission reactor 22 serves as a refrigerant is supplied when a carbon content compound is used, temperature of a carbon content compound can be raised (evaporation). Therefore, the combustion temperature of a combustion style can be raised by using as a fuel the carbon content compound which carried out the preheating in this way, and it is economical.

[0024] As mentioned above, although this invention has been explained with reference to the gestalt of operation, this invention is not limited to a configuration given in the gestalt of operation described above in any way, and also includes the gestalt and modification of other operations which are considered within the limits of the matter indicated by the claim. For example, in the gestalt of said 1st operation, the case where all the insides of a fission reactor were refractory material was explained. However, it is also possible for using only the lower inside of a fission reactor as refractory material to use all the insides except the up inside of a fission reactor as refractory material according to the temperature distribution of the height direction of a fission reactor. As compared with the case where many refractory material is used by this since the arrangement location of refractory material was chosen according to the manufacture temperature of fullerene, it is economical.

[0025] Moreover, in the gestalt of said operation, although the case where refractory material had been arranged to the fission reactor inside was explained, it is also possible to cover refractory material to the fission reactor inside. Since thickness of the refractory material which projects from the inside of a furnace body can be made thin by this as compared with the case where refractory material is arranged, the gas stream in a fission reactor can be brought more close to a laminar flow. And in the gestalt of said operation, although a carbon content compound is explained about combustion, for example, when incomplete combustion was carried out and fullerene is made to generate, even when perfect combustion is carried out, fullerene may generate it.

[0026]

[Effect of the Invention] In the manufacturing installation of fullerene according to claim 1 to 10, heat dissipation of the fission reactor lower part which serves as an elevated temperature most can be controlled with refractory material. Therefore, since homogeneity is made to evaporate the carbon content carbide used as a raw material, it is made to react and the temperature in a fission reactor can fully be raised, the manufacturing installation of the fullerene which can generate the fullerene of the stable quality can be offered. Moreover, since damage on a fission reactor can be controlled, the frequency of the repair activity of a fission reactor can be reduced, and the productivity of fullerene is raised, and the repair costs of a fission reactor can be reduced, and it is economical. While being able to control especially heat dissipation of the fission reactor lower part which serves as an elevated temperature most with refractory material in the manufacturing installation of fullerene according to claim 2, the fission reactor upper part can be cooled by the water-cooled section. Therefore, since control of heat dissipation and cooling of a fission reactor can be performed according to the temperature distribution of the height direction of a fission reactor, a repair activity can be reduced, and while raising the productivity of fullerene, the manufacturing installation of the fullerene from which workability becomes good can be offered. In the manufacturing installation of fullerene according to claim 3, since the configuration of the water-cooled section can be simplified, it is economical.

[0027] In the manufacturing installation of fullerene according to claim 4, since the water-cooled section can be cooled easily, workability is good. In the manufacturing installation of fullerene according to claim 5, since it constitutes from the steel or the alloy which can bear the furnace body of a fission reactor at an elevated temperature, when the temperature in a fission reactor is fully raised, damage by the heat of a furnace body can be reduced. Therefore, since a fission reactor usable for a long period of time can be offered, economical efficiency becomes good. In the manufacturing installation of fullerene according to claim 6, when the temperature in a fission reactor is fully raised, while being able to control damage on the refractory material by heat, heat dissipation can be controlled with refractory material. Therefore, since the endurance over the heat of a fission reactor is raised further, the productivity of fullerene is raised, moreover the repair costs of a fission reactor can be reduced, and it is economical.

[0028] In the manufacturing installation of fullerene according to claim 7, since the pressure in a fission reactor is set to 10 - 500torr, the generation effectiveness of fullerene can be raised. In the manufacturing installation of fullerene according to claim 8, since the gas stream in a fission reactor is made into a laminar flow, the residence time of the fullerene precursor in the generation field of fullerene and fullerene can be lengthened further, and the generation effectiveness of fullerene can be raised. In the manufacturing installation of fullerene according to claim 9, since generation of fullerene is performed under a thin oxygen condition, the temperature distribution of the generation field of fullerene are made into homogeneity, and the fullerene of the stable quality can be manufactured. In the manufacturing installation of fullerene according to claim 10, since temperature in a fission reactor is made into a 600-2300-degree C elevated temperature, make homogeneity evaporate a carbon content compound, it is made to react, and the fullerene of the stable quality can be manufactured.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacturing installation of the fullerene which can manufacture fullerene (for example, C60, C70 grade).

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PRIOR ART

[Description of the Prior Art] Fullerene (henceforth fullerene) is the generic name of the third carbon allotrope which ranks second to a diamond and a graphite, and as represented in C60, C70, etc., it is the carbon molecule of the shape of hollow husks closed in the network of five membered-rings and six membered-rings. Although it is comparatively that existence of this fullerene was finally checked and it is a comparatively new carbon material, it is admitted that that special molecular structure, therefore specific physical property are shown, for example, innovative application development is being quickly developed over the wide range following fields.
(1) Since manufacture of an artificial diamond with a fine crystal grain child is attained by using application fullerene to a superhard ingredient as a precursor, use to an abrasion resistance material with added value is expected.
(2) By using application C60 derivative and the optical device to drugs, research as an application of an anticancer agent, an acquired immunode-ficiency syndrome, osteoporosis, the Alzheimer remedy, a contrast medium, a stent ingredient, etc. is advanced.
(3) It is discovered that the superconducting material which has a high transition temperature called 18K with doping metallic potassium in the application fullerene thin film to a superconducting material can be manufactured, and since various, attract attention.
(4) By mixing C60 with the application resist to semi-conductor manufacture, it uses that resist structure is strengthened further and the application to manufacture of a next-generation semi-conductor is expected. Thus, since fullerene is various as the exotic material which bears the next generation, and new materials, it attracts attention. In addition, C60 and C70 are comparatively easy to compound also in the fullerene which has various carbon numbers, and it is expected that future need so also increases explosively.
[0003] Moreover, the approach shown below is mentioned as the manufacture approach of fullerene learned now.
(1) Laser vacuum deposition : how to irradiate the pulse laser of a high energy consistency at the carbon target placed into rare gas, and compound by evaporation of a carbon atom. First, the quartz tube with which rare gas flows is placed into an electric furnace, and a graphite sample is placed into the quartz tube. And the soot (soot) containing fullerene, such as C60 and C70, is made to adhere to the wall of the quartz tube with which near the electric furnace outlet got cold by irradiating laser and evaporating it in a graphite sample, from the upstream of the flow of gas. In addition, since this laser vacuum deposition has the slight evaporation per laser shot of a graphite sample, it is unsuitable for extensive manufacture.
(2) Resistance heating method : the approach to which carry out energization heating and a graphite rod is made to sublimate in the container of the vacuum filled with gaseous helium. In addition, since this resistance heating method has the large electric resistance loss in a circuit, it is unsuitable for extensive manufacture.
(3) Arc discharge method : the approach to which the carbon of a lifting and an anode plate is made to sublimate arc discharge in the condition of having contacted two graphite electrodes lightly in the gaseous helium in dozens kPa(s), or having detached about 1-2mm. This arc discharge method is used

for extensive manufacture on a current works scale.
(4) Radio frequency heating method : how to heat a sink and a graphite raw material in a graphite raw material by RF induction, and to evaporate an eddy current instead of using resistance heating and arc discharge.
(5) Combustion method : the approach of carrying out the incomplete combustion of the hydrocarbon raw materials, such as benzene, in the mixed gas of inert gas, such as helium, and oxygen. Since several% of a benzene fuel serves as soot and those about 10% becomes fullerene when this combustion method is used, manufacture effectiveness is not good. However, the soot (fullerene etc.) to reproduce is observed as the mass-producing method for opposing an arc discharge method at the point usable to liquid fuel etc., and the point that a manufacturing installation is simple.
(6) Naphthalene thermal decomposition method : the approach of carrying out the pyrolysis of the naphthalene at about 1000 degrees C.
[0004] Although the synthesis method of various fullerene to current was proposed as described above, the method of manufacturing fullerene cheaply and in large quantities by any approach until now was not established. However, toward mass production method of fullerene, the maximum temperature in the synthetic region of fullerene is low temperature comparatively compared with about 1700 degrees C and other approaches, and can manufacture [be / it / under / of the above-mentioned approach / setting] a combustion method easily compared with other approaches. For example, the manufacture approach of the fullerene which a carbon content compound is burned in a flame in the Patent Publication Heisei No. 507879 [six to] official report, and collects condensates in it is proposed.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] In the manufacturing installation of fullerene according to claim 1 to 10, heat dissipation of the fission reactor lower part which serves as an elevated temperature most can be controlled with refractory material. Therefore, since homogeneity is made to evaporate the carbon content carbide used as a raw material, it is made to react and the temperature in a fission reactor can fully be raised, the manufacturing installation of the fullerene which can generate the fullerene of the stable quality can be offered. Moreover, since damage on a fission reactor can be controlled, the frequency of the repair activity of a fission reactor can be reduced, and the productivity of fullerene is raised, and the repair costs of a fission reactor can be reduced, and it is economical. While being able to control especially heat dissipation of the fission reactor lower part which serves as an elevated temperature most with refractory material in the manufacturing installation of fullerene according to claim 2, the fission reactor upper part can be cooled by the water-cooled section. Therefore, since control of heat dissipation and cooling of a fission reactor can be performed according to the temperature distribution of the height direction of a fission reactor, a repair activity can be reduced, and while raising the productivity of fullerene, the manufacturing installation of the fullerene from which workability becomes good can be offered. In the manufacturing installation of fullerene according to claim 3, since the configuration of the water-cooled section can be simplified, it is economical.
[0027] In the manufacturing installation of fullerene according to claim 4, since the water-cooled section can be cooled easily, workability is good. In the manufacturing installation of fullerene according to claim 5, since it constitutes from the steel or the alloy which can bear the furnace body of a fission reactor at an elevated temperature, when the temperature in a fission reactor is fully raised, damage by the heat of a furnace body can be reduced. Therefore, since a fission reactor usable for a long period of time can be offered, economical efficiency becomes good. In the manufacturing installation of fullerene according to claim 6, when the temperature in a fission reactor is fully raised, while being able to control damage on the refractory material by heat, heat dissipation can be controlled with refractory material. Therefore, since the endurance over the heat of a fission reactor is raised further, the productivity of fullerene is raised, moreover the repair costs of a fission reactor can be reduced, and it is economical.
[0028] In the manufacturing installation of fullerene according to claim 7, since the pressure in a fission reactor is set to 10 - 500torr, the generation effectiveness of fullerene can be raised. In the manufacturing installation of fullerene according to claim 8, since the gas stream in a fission reactor is made into a laminar flow, the residence time of the fullerene precursor in the generation field of fullerene and fullerene can be lengthened further, and the generation effectiveness of fullerene can be raised. In the manufacturing installation of fullerene according to claim 9, since generation of fullerene is performed under a thin oxygen condition, the temperature distribution of the generation field of fullerene are made into homogeneity, and the fullerene of the stable quality can be manufactured. In the manufacturing installation of fullerene according to claim 10, since temperature in a fission reactor is made into a 600-2300-degree C elevated temperature, make homogeneity evaporate a carbon content compound, it is made to react, and the fullerene of the stable quality can be manufactured.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, there are the following problems in the manufacture approach of the fullerene by the above-mentioned combustion method. Although it is contained in the soot-like matter and generated, since the rate of fullerene of the fullerene contained in the soot-like matter in a combustion method is low, it is not economical. Then, it has been a big technical problem how the generation rate of this fullerene is raised. Moreover, in order to make the fullerene of the quality stabilized using the combustion method generate, it is necessary to make homogeneity evaporate the carbon content compound used as a raw material, and to make it react. For that purpose, since it is necessary to heat the carbon content compound (hydrocarbon raw material) used as a raw material to an elevated temperature, a fission reactor may receive damage with heat. Since the repair activity of a fission reactor increases by this, it is not reduce the productivity of fullerene and needed [much] for a repair activity, and economical. This invention was made in view of this situation, and aims at offering the manufacturing installation of the fullerene which can be manufactured cheaply and easily in large quantities [fullerene / of the stable quality].

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MEANS

[Means for Solving the Problem] the manufacturing installation which the carbon content compound and oxygen content gas which the manufacturing installation of the fullerene concerning this invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, and serve as a raw material are burned, and manufactures fullerene -- it is -- a fission reactor -- the lower inside is refractory material at least. Thus, with constituting, heat dissipation of the fission reactor lower part which serves as an elevated temperature most can be controlled with refractory material. Here, while having refractory material inside [lower] a fission reactor in the manufacturing installation of the fullerene concerning this invention, it is desirable to prepare the water-cooled section in the up outside of a fission reactor. Thus, while being able to control with constituting heat dissipation of the fission reactor lower part which serves as an elevated temperature most with refractory material, the fission reactor upper part can be cooled by the water-cooled section. In the manufacturing installation of the fullerene concerning this invention, it is desirable to use the water-cooled tube and/or a jacket for the water-cooled section. Thus, the configuration of the water-cooled section can be simplified with constituting.
[0007] In the manufacturing installation of the fullerene concerning this invention, it is desirable to use water or an organic solvent for the refrigerant of the water-cooled section. Thereby, the water-cooled section can be cooled easily. In the manufacturing installation of the fullerene concerning this invention, it is desirable to constitute the furnace body of a fission reactor from heat-resisting steel or a heat-resistant alloy. Thus, since the furnace body of a fission reactor is constituted from the steel or the alloy which can bear an elevated temperature, when the temperature in a fission reactor is fully raised, damage by the heat of a furnace body can be reduced. In the manufacturing installation of the fullerene concerning this invention, it is desirable to use refractory material as alumina system refractory material or magnesia system refractory material. When the temperature in a fission reactor is fully raised, while being able to control damage on the refractory material by heat by this, heat dissipation can be controlled with refractory material.
[0008] In the manufacturing installation of the fullerene concerning this invention, it is desirable to set the pressure in a fission reactor to 10 - 500torr. In the manufacturing installation of the fullerene concerning this invention, it is desirable to make the gas stream in a fission reactor into a laminar flow. In the manufacturing installation of the fullerene concerning this invention, it is desirable that exceed 0 or 0 and the inert gas not more than 90 mol % is contained in oxygen content gas. In the manufacturing installation of the fullerene concerning this invention, it is desirable to make temperature in a fission reactor into the range of 600-2300 degrees C.
[0009]
[Embodiment of the Invention] Then, referring to the attached drawing, it explains per gestalt of the operation which materialized this invention, and an understanding of this invention is presented. The explanatory view of the manufacturing installation of the fullerene which drawing 1 requires for the gestalt of operation of the 1st of this invention here, and drawing 2 are the explanatory views of the

manufacturing installation of the fullerene concerning the gestalt of operation of the 2nd of this invention.

[0010] As shown in drawing 1 , the manufacturing installation 10 of the fullerene concerning the gestalt of operation of the 1st of this invention With the fission reactor 12 equipped with the burner section 11 for combustion which has a carbon content compound feed hopper (not shown) and oxygen content gas supply opening (not shown) the equipment which the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene -- it is -- a fission reactor 12 -- the lower inside (the gestalt of this operation all insides) is refractory material 13 at least. Hereafter, it explains in detail.

[0011] The furnace body 14 of a fission reactor 12 consists of heat-resisting steel, and serves as an approximate circle column-like configuration, and an outer diameter D is [about 0.8-5m and height H of the magnitude] about 2 to 4 times of for example, the outer diameter D. The piping 15 for sending the fullerene generated in the fission reactor 12 to the separation section (not shown) of the downstream is connected to the upper limit of this furnace body 14 in one. In addition, in the furnace body 14, an ingredient which is different also considering the furnace body 14 as the same ingredient in a pyrosphere and a low-temperature region may be used. In the temperature region to be used, specifically as heat-resisting steel which constitutes the furnace body 14 that what is necessary is just usable heat-resisting steel For example, Mo steel, Cr-Mo steel, Mo-V steel, Cr-Mo-V steel, Cr-nickel-Mo steel, Low alloy heat-resisting steel (usable at the temperature of 500 degrees C or less), such as Cr-Mo-W-V steel, Martensitic heat resisting steel (usable at below the temperature of the range of 600-650 degrees C), Stainless steel system heat-resisting steel with a high carbon content etc. can be used for a while from the object for anticorrosion like the austenitic heat resisting steel (usable to the temperature near 700 degree C) of ferritic heat resisting steel, SUS304, SUS304L, SUS316, SUS316L, and SUS310S grade, and heat resistant cast steel. Moreover, a furnace body may be constituted from a heat-resistant alloy, and the iron base superalloy (usable to the temperature near about 760 degree C) divided roughly into a Cr-nickel-Fe system and a Cr-nickel-Co-Fe system, an Ni base superalloy (usable at 900-1000-degree C high temperature), Co radical superalloy (usable in a 800-850-degree C temperature requirement), etc. can be used as a heat-resistant alloy, for example.

[0012] On the other hand, two or more carbon content compounds used as a fuel, carbon content compound feed hoppers which supply oxygen content gas, respectively, and oxygen content gas supply openings are prepared in the burner section 11 for combustion prepared in the pars basilaris ossis occipitalis of a fission reactor 12, respectively, and the combustion style for making fullerene generate is formed in it. For this reason, whenever [furnace temperature / of the lower part of a fission reactor 12] tends to become the highest. In addition, it may be arbitrary, and plane view of the configuration of two or more of these carbon content compound feed hoppers and oxygen content gas supply opening may be carried out, and they may be circular, an ellipse form, a rectangle, a polygon, etc. and the indeterminate form of a gourd mold substantially. Moreover, although the arrangement location of a carbon content compound feed hopper and oxygen content gas supply opening is arbitrary, in order to pass a combustion style to homogeneity above the fission reactor 12, the thing which were centered on the axial center of a fission reactor 12 and for which it is regular intervals and two or more feed hoppers are arranged on the same or a concentric circle periphery is desirable. Moreover, the vacuum pump (not shown) which is an example of a vacuum means is connected to a fission reactor 12, and the pressure in a fission reactor 12 is made under into atmospheric pressure in it.

[0013] And the feed hopper 16 for supplying the carbon content compound used as the raw material of fullerene is formed in the bottom flank of a fission reactor 12. In addition, although the number of this feed hopper 16 is arbitrary, in order to make homogeneity generate fullerene in a fission reactor 12, it is desirable to form a majority of these feed hoppers 16 in the flank of a fission reactor 12 at equal spacing. Moreover, in order that the location of a feed hopper 16 may lengthen the residence time of the fullerene precursor made to generate in a fission reactor 12, and fullerene, it is desirable the fission reactor 12 bottom and to prepare in the lower limit section further. Therefore, the feed hopper 16 is possible also for preparing a large number in the pars basilaris ossis occipitalis (two-dot chain line location in drawing

1) of a fission reactor 12, and it is desirable in this case the same or to arrange on a concentric circle periphery focusing on the axial center of a fission reactor 12. Under the present circumstances, even if the open end of a feed hopper 16 is on the base of a fission reactor 12, and an abbreviation same flat surface, it is possible to have projected and to also make it incline toward the axial center of a fission reactor 12.

[0014] Inside the furnace body 14 of a fission reactor 12, the refractory material 13 which consists of a well-known alumina system refractory material or magnesia system refractory material is arranged conventionally. If the temperature in a fission reactor 12 is to about 1800 degrees C at this time, it is desirable to use alumina system refractory material, and when going up to about 2300 degrees C, it is desirable to use magnesia system refractory material. Moreover, it is also possible to change suitably into alumina system refractory material or magnesia system refractory material the class of refractory material arranged inside a fission reactor 12 according to the temperature distribution of the height direction of a fission reactor 12. Thereby, the manufacturing installation of the economical fullerene according to the manufacture conditions of fullerene can be offered. In addition, although the thickness of refractory material 13 is arbitrary, it is desirable to set in consideration of the temperature in a fission reactor 12 to the about thickness which can control damage on the furnace body 14, for example, 3-10cm.

[0015] Then, how to manufacture fullerene is explained using the manufacturing installation 10 of the above-mentioned fullerene. First, the carbon content compound and oxygen content gas which serve as a fuel from the burner section 11 for combustion are supplied, and a combustion gas style hot by burning these is generated toward the upper part (downstream) of a fission reactor 12. And the carbon content compound used as a raw material is supplied in a fission reactor 12 from a feed hopper 16, a carbon content compound is burned by making the inside of a fission reactor 12 under into atmospheric pressure (incomplete combustion), and fullerene is made to generate. Hereafter, it explains in detail.

[0016] Even if the carbon content compound and oxygen content gas used as this fuel are premixed combustion mixed and burned before entering in a fission reactor 12, they may be diffusive burning which supplies in a fission reactor 12, respectively and is burned from the independent nozzle. Moreover, premixed combustion and diffusive burning may be combined. Thus, it may be the purpose to generate the hot combustion style for making fullerene generate in the lower part of a fission reactor 12, and the combustion method may be what kind of conventionally well-known combustion methods, such as the above-mentioned premixed combustion, diffusive burning and laminar-flow combustion, turbulent flow combustion, and elevated-temperature air combustion. Moreover, combustion may be perfect combustion or may be incomplete combustion.

[0017] Aromatic series (system) hydrocarbons, etc. such mixture, etc., such as the aliphatic series saturation which can use the thing of arbitration as a carbon content compound used as a fuel and a raw material, for example, has a straight chain or branched chain, such as petroleum system liquid fuel, such as petroleum system liquid fuel, such as fuel gas, such as hydrogen, a carbon monoxide, natural gas, and petroleum gas, and a fuel oil, and creosote oil, methane, ethane, a propane, ethylene, and a propylene, or unsaturated hydrocarbon, benzene, toluene, O-xylene, meta xylene, para xylene, naphthalene, and an anthracene, be mentioned The aromatic hydrocarbon refined especially is desirable and it is desirable to use aromatic hydrocarbon, such as benzene and toluene, especially. In addition, its higher one is desirable, and when using aromatic hydrocarbon especially, it is so good that the purity of the purity of a raw material is close to 100%.

[0018] Moreover, it is desirable to use pure oxygen (that whose amount of inert gas in oxygen content gas is 0%), and the gas which exceeds 0 and contains the inert gas not more than 90 mol % (for example, gaseous helium, argon gas) as oxygen content gas. Here, the fullerene which oxygen changed the ambient atmosphere in a fission reactor into the thin condition, and was equipped with uniform quality can be manufactured so that there are many amounts of the inert gas in oxygen content gas, but when the amount of inert gas exceeds 90-mol %, the amount of oxygen for making heat energy required for manufacture of fullerene cannot be secured. In addition, as for inert gas, it is possible to supply from the exclusive nozzle for supply, and to also make it mix beforehand in a carbon content compound

and/or oxygen content gas.
[0019] Here, in order that the pressure in a fission reactor 12 may raise the generation effectiveness of the fullerene to generate, it is desirable to be preferably referred to as 50 - 400torr, and further 100 - 400torr ten to 500 torr under atmospheric pressure. Moreover, in order to lengthen the fullerene precursor in a fission reactor 12, and the residence time of fullerene, it is desirable to make the gas stream in a fission reactor 12 into a laminar flow (for example, 10 - 100 cm/sec extent). And in order to make a carbon content compound react by making homogeneity evaporate (pyrolysis), it is desirable to make enough temperature in the generation field 12 of fullerene, i.e., a fission reactor, into an elevated-temperature ambient atmosphere, and it is desirable to make preferably 600-2300 degrees C (mean temperature) of temperature in a fission reactor 12 into the range of 1000-2000 degrees C and further 1200-1800 degrees C. The carbon content compound used as a raw material is burned under this condition (incomplete combustion), and fullerene is made to generate.
[0020] The rough fullerene (for example, fullerene containing the high order fullerene which has C60, C70, and the molecular weight beyond this) and the other soot components which were generated with the fission reactor 12 are separated from combustion gas in the separation section. And what is necessary is just to separate fullerene and other soot components by a well-known solvent extraction method, the well-known sublimating method, etc. conventionally. In addition, in case it is made to generate with a combustion method, by carrying out a temperature control, fullerene may be made into a gaseous state and fullerene may be separated with other soot components in the separation section by making other soot components into a solid state. For that, it is required to make temperature of the rough fullerene included in the separation section into 300 degrees C or more. In addition, at less than 300 degrees C, since a part of generated fullerene will be in a solid state and cannot pass the separation section, the amount of recovery may decrease. On the other hand, if temperature is too high, degradation of the separation section may be promoted, and a part of soot components other than fullerene may pass, and it may mix the separation section into the collected fullerene. For this reason, it is desirable to make temperature of rough fullerene into 300-2300 degrees C and further 300-1500 degrees C.
[0021] Next, although the manufacturing installation 20 of the fullerene concerning the gestalt of operation of the 2nd of this invention is explained, since it is the same as the manufacturing installation 10 of the fullerene concerning the gestalt of operation of the 1st of this invention except having had refractory material 21 inside [lower] the fission reactor 22, and having formed the water-cooled section 23 in the upper part of a fission reactor 22, the same number is given to the same component and detailed explanation is omitted. As shown in drawing 2 , the manufacturing installation 20 of the fullerene concerning the gestalt of operation of the 2nd of this invention With the fission reactor 22 equipped with the burner section 11 for combustion which has a carbon content compound feed hopper (not shown) and oxygen content gas supply opening (not shown) It is equipment which the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene, and while having refractory material 21 inside [lower] a fission reactor 22, the water-cooled section 23 is formed in the up outside of a fission reactor 22.
[0022] Refractory material 21 is arranged in 1 / about four to 1/2 location of the lower part of the fission reactor 22 with which whenever [furnace temperature / of a fission reactor 22] becomes the highest, for example, the height of a fission reactor 22. Although the upper limit of this refractory material 21 has projected only the part of the thickness of refractory material 21 from the inside of the furnace body 14, it is possible to also make the upper limit section of refractory material incline toward the inside of the furnace body 14. Thereby, since the gas stream in a fission reactor 22 can be brought more close to a laminar flow, the fullerene equipped with uniform quality can be manufactured. Moreover, the water-cooled section 23 consists of the water-cooled tubes 24, water is used for a refrigerant, and water (for example, about 10-30 degrees C) is continuously supplied to the interior of the water-cooled tube 24. this water-cooled tube 24 -- the upper limit from the lower limit of the water-cooled section 23 -- applying -- the up outside of the furnace body 14 -- being spiral (continuous) -- it is also possible to also arrange and to arrange independently according to an individual in the height direction of a fission

reactor 22, respectively. Here, when the water-cooled tube 24 has been arranged independently according to an individual, it is also possible to pour the water (for example, about 5-50 degrees C) of temperature which is different in each water-cooled tube 24 according to the temperature distribution of the height direction of a fission reactor 22, respectively. Since it can adjust by this to the temperature of extent from which the furnace body 14 does not receive damage according the temperature of the furnace body 14 to heat, it attains [long-term use of a fission reactor 22] and is economical.
[0023] And the jacket used as dual structure can also be used for the water-cooled section, and it is also possible to use it combining this jacket and water-cooled tube 24. In addition, it is also possible to use the oil which is an organic solvent, and the above mentioned carbon content compound, without using water for a refrigerant. Here, since the carbon content compound with which the heat generated out of a fission reactor 22 serves as a refrigerant is supplied when a carbon content compound is used, temperature of a carbon content compound can be raised (evaporation). Therefore, the combustion temperature of a combustion style can be raised by using as a fuel the carbon content compound which carried out the preheating in this way, and it is economical.
[0024] As mentioned above, although this invention has been explained with reference to the gestalt of operation, this invention is not limited to a configuration given in the gestalt of operation described above in any way, and also includes the gestalt and modification of other operations which are considered within the limits of the matter indicated by the claim. For example, in the gestalt of said 1st operation, the case where all the insides of a fission reactor were refractory material was explained. However, it is also possible for using only the lower inside of a fission reactor as refractory material to use all the insides except the up inside of a fission reactor as refractory material according to the temperature distribution of the height direction of a fission reactor. As compared with the case where many refractory material is used by this since the arrangement location of refractory material was chosen according to the manufacture temperature of fullerene, it is economical.
[0025] Moreover, in the gestalt of said operation, although the case where refractory material had been arranged to the fission reactor inside was explained, it is also possible to cover refractory material to the fission reactor inside. Since thickness of the refractory material which projects from the inside of a furnace body can be made thin by this as compared with the case where refractory material is arranged, the gas stream in a fission reactor can be brought more close to a laminar flow. And in the gestalt of said operation, although a carbon content compound is explained about combustion, for example, when incomplete combustion was carried out and fullerene is made to generate, even when perfect combustion is carried out, fullerene may generate it.

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* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view of the manufacturing installation of the fullerene concerning the gestalt of operation of the 1st of this invention.
[Drawing 2] It is the explanatory view of the manufacturing installation of the fullerene concerning the gestalt of operation of the 2nd of this invention.
[Description of Notations]
10: The manufacturing installation of fullerene, the burner section for 11:combustion, 12:fission reactor, 13:refractory material, 14:furnace body, 15:piping, 16:feed hopper, the manufacturing installation of 20:fullerene, 21:refractory material, 22:fission reactor, the 23:water-cooled section, 24 : water-cooled tube

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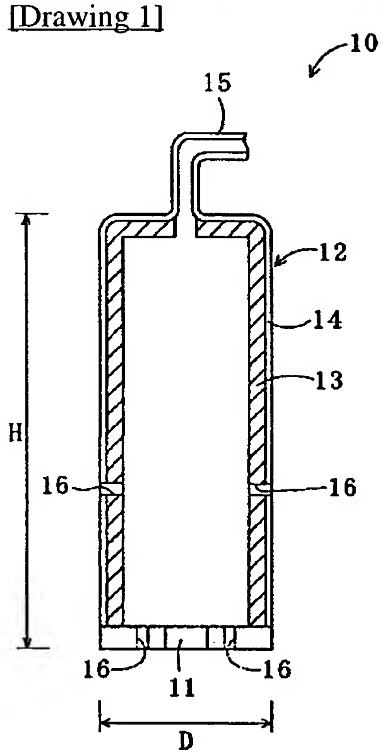
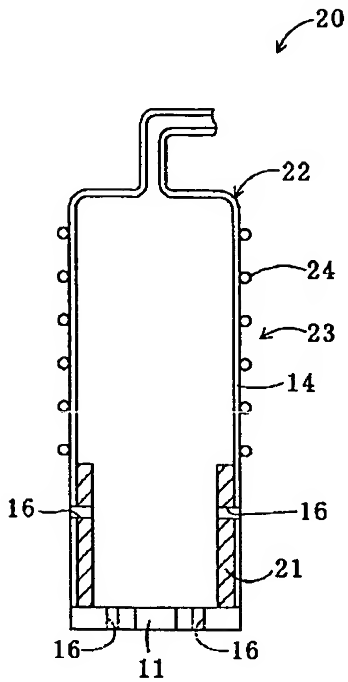
DRAWINGS

[Drawing 1]



[Drawing 2]



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